DOCUMENT RESUME

ED 325 071 IR 014 655

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TITLE Does Interactivity Matter in Video-Based Off-Campus Graduate Engineering Education?
SPONS AGENCY American Society for Engineering Education, Washington, DC. Center for Professional Development.
PUB DATE 88
NOTE 18p.; For a related paper, see IR 014 656.
PUB TYPE Statistical Data (110) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Age Differences; Comparative Analysis; *Distance Education; *Engineering Education; Graduate Students; Higher Education; Instructional Design; *Interactive Video; *Intermode Differences; *Learner Controlled Instruction; School Surveys; *Videotape Recordings

ABSTRACT

A survey was conducted to seek evidence of variation in student performance based on age, gender, graduate major, and instructional modality--i.e., traditional on-campus instruction, non-interactive videotape delivery, and interactive delivery systems complemented with real-time audio feedback. Responses were received from 8 out of 50 academic institutions to whom requests for data were sent, resulting in a sample size of 8,431 graduate students. The sample was broken down into the following categories: (1) on-campus degree-seeking students; (2) on-campus non-degree students; (3) off-campus degree-seeking students enrolled in courses delivered in a non-interactive (videotape) mode; (4) off-campus non-degree students taking courses in a non-interactive (videotape) mode; (5) off-campus degree-seeking students enrolled in courses offered interactively via microwave, ITFS (Instructional Television Fixed Service), or satellite with real-time feedback; and (6) off-campus non-degree students enrolled in courses offered interactively via microwave, ITFS, or satellite with real-time feedback. Analyses of the data indicate that off-campus students perform better as they are able to control where and when learning occurs. Also, student age influences student performance, as measured by grades, more than gender. Finally, videotape is significant as a learning medium for male students over the age of 26. (5 references) (DB)

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DOES INTERACTIVITY MATTER IN VIDEO-BASED OFF-CAMPUS GRADUATE ENGINEERING EDUCATION?

A Comparative Evaluation funded by the
Center for Professional Development
American Society for Engineering Education

by

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While research (Gibbons, 1977; Stone, 1986, 1987a, 1987b, 1988) has established "candid-classroom's" ability to deliver off-campus graduate engineering education without significantly effecting learning, questions remained concerning the necessity and degree of direct real-time interaction between on-campus faculty and video-based students working in industry.

Seeking to respond to this issue, ASEE's Center for Professional Development funded the current effort which was designed to: (1) horizontally expand available data bases beyond any one institution and (2) seek evidence of variation in student performance (with grades used as an outcome measure) when observed against the following independent variables: age, gender, graduate major, and instructional modality (traditional on-campus instruction, non-interactive videotape delivery, and interactive delivery systems complimented with real-time audio feedback).

The following is a partial summary of data and findings whose full scope is scheduled for publication in monograph form by the American Society for Engineering Education.

SAMPLE SELECTION/DESCRIPTION

Letters soliciting institutional participation were sent to over 50 colleges of engineering including all participants in the Association for Media-Based Continuing Education for Engineers.

Universities were requested to provide data on and off-campus engineering graduate students for a period of 1 to 3 years. Respondents were asked to limit their on-campus sample to graduates from U.S. undergraduate institutions (thereby removing the major influence of foreign-born students who were not broadly represented in the off-campus cohort).

Requested data included: student gender, chronological age, graduate quality point average, and a course-by-course record of each individual's performance within the study period.

IR014655

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Out of the approximately 50 institutions to whom requests were sent, 8 responded positively. These include: Arizona State University (n=1,388), Auburn University (n=172), California State University, Chico (n=802), Colorado State University (n=245), Oklahoma State University (n=78), Purdue University (n=1,225), University of Arizona (n=555), and Washington State University (n=262). Data previously obtained from a 1981-1985 University of Massachusetts (n=3,704) survey was added to these responses.

The survey yielded a data base of n=8,431. As this effort sought significant variations in performance between students participating in different learning modalities, the sample was divided into 6 instructional categories:

Category #0:	Traditional on-campus graduate students
Category #1:	On-campus non-degree graduate students
Category #2:	Off-campus degree-seeking graduate students enrolled courses delivered in a non-interactive (videotape) mode
Category #3:	Off-campus non-degree graduate students taking courses in a non-interactive (videotape) mode
Category #4:	Off-campus degree-seeking graduate students enrolled in courses offered interactively (microwave, ITFS, satellite, etc.) with real-time feedback
Category #5	Off-campus non-degree graduate students enrolled in courses offered interactively (microwave, ITFS, satellite, etc), with real-time feedback.

The following tables summarize the sample:

TABLE #1
Student Sample Divided by
Offering Institution and Delivery Methodology

Offering University Frequency Row % Column %	On-Campus Degree	On-Campus Non-Deg	Off-Campus V'tape Degree	Off-Campus V'tape Non-Deg	Off-Campus Interac Degree	Off-Campus Interac Non-Deg	Total
	Student Category						
Arizona State	466 33.57 12.40	90 6.48 79.65	0 0 0	0 0 0	390 28.10 34.70	422 31.84 30.78	1,388 16.46
Auburn University	49 28.49 1.30	2 1.16 1.77	106 61.63 11.58	15 8.72 1.38	0 0 0	0 0 0	172 2.04
Calif. State University, Chico	218 27.18 5.80	1 0.12 0.88	0 0 0	0 0 0	194 24.19 17.26	389 48.50 27.09	802 9.51
Colorado State University	169 68.98 4.50	4 1.63 3.54	33 13.47 3.61	39 15.92 3.60	0 0 0	0 0 0	249 2.91
Oklahoma State University	48 61.54 1.28	0 0 0	7 8.97 0.77	0 0 0	9 11.54 0.80	14 17.95 0.97	78 0.93
Purdue University	379 30.94 10.08	1 0.08 0.88	56 4.57 6.12	116 9.47 10.70	214 17.47 19.04	459 37.47 31.96	1,225 14.53
University of Arizona	210 37.84 5.59	15 2.70 13.27	15 2.70 1.64	76 13.69 7.01	129 23.24 11.48	110 19.82 7.66	555 6.58
University of Mas'chusetts	2,168 58.53 57.67	0 0 0	698 18.84 76.28	838 22.62 77.31	0 0 0	0 0 0	3,704 43.93
Washington State University	52 19.85 1.38	0 0 0	0 0 0	0 0 0	188 71.76 16.73	22 8.40 1.53	262 3.11
Total	3,759 44.59	113 1.34	915 10.85	1,084 12.86	1,124 13.33	1,436 17.03	8,431 100.00

TABLE #2
Student Gender by
Delivery Methodology *

Student Gender Frequency Row % Column %	On-Campus Degree	On-Campus Non-Deg	Off-Campus V'tape Degree	Off-Campus V'tape Non-Deg	Off-Campus Interac Degree	Off-Campus Interac Non-Deg	Total
	Student Category						
Male	1,319	89	193	218	958	1,226	4,003
	32.95	2.22	4.82	5.45	23.93	30.63	47.48
	35.09	78.76	21.09	20.11	85.23	85.38	
Female	262	24	24	28	158	210	706
	37.11	3.40	3.40	3.97	22.38	29.75	8.37
	6.97	21.24	2.62	2.58	14.06	14.62	
Unknown	2,178	0	698	838	8	0	3,722
	58.52	0	8.28	9.94	0.09	0	44.15
	57.94	0	76.28	77.31	0.71	0	
Total	3,759	113	915	1,084	1,124	1,436	8,431
	44.59	1.34	10.85	12.86	13.33	17.03	100.00

* Note that out of a total sample of n=8,431, gender information was available for a subset of n=4,706 data points (55.85% of the total). Of the remaining, n=3,722, the preponderance were from the University of Massachusetts sub-sample where gender was not a part of the original study.

TABLE #3
Student Sample Divided by
Chronological Age

Chronological Age Frequency Row % Column %	On-Campus Degree	On-Campus Non-Deg	Off-Campus V'tape Degree	Off-Campus V'tape Non-Deg	Off-Campus Interac Degree	Off-Campus Interac Non-Deg	Total
	Student Category						
22-25	2,330	41	210	342	383	522	3,828
Years	60.87	1.07	5.49	8.93	10.01	13.64	46.41
	63.33	36.94	23.00	31.73	34.14	38.78	
26-30	901	47	364	323	447	463	2,545
Years	35.40	1.85	14.30	12.69	17.56	18.19	30.05
	24.49	42.34	39.87	29.96	39.84	34.40	
31-35	282	13	191	214	184	179	1,063
Years	26.53	1.22	17.97	20.13	17.31	16.84	12.89
	7.67	11.71	20.92	19.85	16.40	13.30	
36-40	90	3	103	86	70	90	442
Years	20.36	0.68	23.30	19.46	15.84	20.36	5.36
	2.45	2.70	11.28	7.98	6.24	6.69	
Over 40	76	7	45	113	38	92	371
Years	20.49	1.89	12.13	30.46	10.24	24.80	4.50
	2.07	6.31	4.93	10.48	3.39	6.84	
Total	3,759	113	915	1,084	1,124	1,436	8,431
	44.59	1.34	10.85	12.86	13.33	17.03	100.00

Beginning with Table #4, interaction of the independent variables, instructional modalities, and student performance become evident.

TABLE #4
Interaction Between Instructional
Modality and Performance
(as Measured by Grades)

Approximate 95% Confidence Intervals

Cat'gry	Description	n	% and n Grades (With .05 Grades Collapsed)	Mean Grd QPA
0	On-Campus Degree	3758	F: 3.75 n= 141 D: 0.80 n= 30 C: 7.56 n= 284 B: 37.29 n=1402 A: 50.60 n=1901	3.30
1	On-Campus Non-Degree	113	F: 30.97 n= 35 D: 3.54 n= 4 C: 7.08 n= 8 B: 38.94 n= 44 A: 19.47 n= 22	2.12
2	Off-Campus Videotape Non-Interactive-Degree	915	F: 1.75 n= 16 D: 0.11 n= 1 C: 5.85 n= 53 B: 36.56 n= 335 A: 55.74 n= 510	3.44
3	Off-Campus Videotape Non-Interactive-Non-Degree	1084	F: 11.44 n= 124 D: 0.37 n= 4 C: 10.79 n= 117 B: 34.96 n= 379 A: 42.44 n= 460	2.96
4	Off-Campus Interactive Degree	1124	F: 7.03 n= 79 D: 0.98 n= 11 C: 6.67 n= 75 B: 30.92 n= 348 A: 54.40 n= 611	3.25
5	Off-Campus Interactive Non-Degree	1436	F: 12.74 n= 183 D: 2.58 n= 37 C: 12.60 n= 181 B: 35.34 n= 508 A: 36.73 n= 527	2.95

TABLE #5
Distribution of Grades within Gender
Cohorts by Instructional Category

Approximate 95% Confidence Intervals

Ca 'gry	Student Gender	n	Mean Grad QPA	Stan Dev
0 On-Campus Degree	Male	1319	3.12	0.031685
	Female	262	3.20	0.063141
	Unknown	2178	3.43	0.014096
1 On-Campus Non-Degree	Male	89	2.06	0.164804
	Female	24	2.37	0.328658
2 Off-Campus Degree V'Tape	Male	193	3.27	0.070933
	Female	24	3.54	0.147186
	Unknown	698	3.49	0.023738
3 Off-Campus Non-Dgr V'Tape	Male	218	2.98	0.090200
	Female	28	3.18	0.218542
	Unknown	838	2.96	0.041848
4 Off-Campus Degree Inter	Male	958	3.23	0.035632
	Female	158	3.33	0.084663
	Unknown	8	3.44	0.220339
5 Off-Campus Non-Dgr Inter	Male	1226	2.78	0.037459
	Female	210	2.96	0.218542
	Unknown	838	2.96	0.082387

TABLE #6
Distribution of Grades within Age
Cohorts by Instructional Category

Approximate 95% Confidence Intervals

Cat'gry	Chronological Age	n	Mean Grad QPA	Stan Dev
0	22 to 25 years	2330	3.33	0.01725
On-	26 to 30 years	901	3.26	0.03113
Campus	31 to 35 years	282	3.21	0.07268
Degree	36 to 40 years	90	3.57	0.07222
	Over 40 years	76	3.14	0.13566
1	22 to 25 years	41	2.12	0.22951
On-	26 to 30 years	47	2.21	0.22747
Campus	31 to 35 years	13	1.77	0.52077
Non-	36 to 40 years	3	0.00	0.00000
Degree	Over 40 years	7	3.29	0.28571
2	22 to 25 years	210	3.38	0.05205
Off-	26 to 30 years	364	3.43	0.03553
Campus	31 to 35 years	191	3.64	0.04165
Degree	36 to 40 years	103	3.33	0.08460
V'Tape	Over 40 years	45	3.28	0.15122
3	22 to 25 years	342	3.09	0.05915
Off-	26 to 30 years	323	2.98	0.07060
Campus	31 to 35 years	214	2.91	0.08829
Non-Dgr	36 to 40 years	86	2.84	0.13576
V'Tape	Over 40 years	113	2.83	0.12454
4	22 to 25 years	383	3.33	0.04774
Off-	26 to 30 years	447	3.09	0.05921
Campus	31 to 35 years	184	3.27	0.08099
Degree	36 to 40 years	70	3.47	0.10953
Inter	Over 40 years	38	3.67	0.08492
5	22 to 25 years	522	2.88	0.05160
Off-	26 to 30 years	463	2.68	0.06420
Campus	31 to 35 years	179	2.83	0.09968
Non-Dgr	36 to 40 years	90	2.85	0.13349
Inter	Over 40 years	92	2.64	0.14460

RESEARCH DESIGN

This study is distinguished from prior comparative research which examined the effects of selected variables on the complete range of student grade performance (0.0 to 4.0). The current effort collapsed grade responses into two categories. In this binary mode, grades of 3.0 and above were considered "success". Performance at less than the 3.0 level was considered "failure."

The success/failure criterion is based on the traditional acceptance that grades of 3.0 or better are considered indicia of success at the graduate level. Performance falling below the 3.0 level is considered unacceptable. Note the following:

TABLE #7
Performance by Student Category
Collapsed by "Success/Failure"

	% "A"	% "B"	% Success	% "C"	% "D"	% "F"	% Failure
Degree Seeking Students							
On-Campus (Live) Degree Category #0	50.6 n= 1901	37.3 n= 1402	87.9 n= 3303	7.56 n= 284	0.80 n= 30	3.75 n= 141	12.1 n= 455
Off-Campus Non-Interactive Degree Category #2	55.7 n= 510	36.6 n= 334	92.3 n= 844	5.85 n= 54	0.11 n= 1	1.75 n= 16	7.7 n= 71
Off-Campus Real-time/Interactive Degree Category #4	54.4 n= 611	30.9 n= 348	85.3 n= 959	6.67 n= 75	0.98 n= 11	7.03 n= 79	14.7 n= 165
Non-Degree Seeking Students							
On-Campus Non-Degree Category #1	19.5 n= 22	38.9 n= 44	58.4 n= 66	7.08 n= 8	3.54 n= 4	30.9 n= 35	41.6 n= 47
Off-Campus Non-Interactive Non-Degree Category #3	42.4 n= 460	35.0 n= 379	77.4 n= 839	10.8 n= 117	0.37 n= 4	11.4 n= 124	22.6 n= 245
Off-Campus Interactive Degree Category #5	36.7 n= 527	35.3 n= 508	72.0 n= 1035	12.6 n= 181	2.58 n= 37	12.7 n= 183	28.0 n= 401

While all following comparisons will be based on this dichotomous approach, mean graduate performance will be displayed for purposes of illustration.

As noted earlier, data was collected from nine universities. A data observation consisted of a university, student, major, and course identifiers, a grade, delivery modality, and the student's chronological age and gender.

Due to particularities present at each of the responding universities, not all majors and departments are present at each institution. In addition, while some programs were able to supply all requests for student data, others were not. This was primarily the case with requests associated with data on individual age and gender.

As a result, a full-factorial model involving grades, university, delivery methodology, major, gender, and age was not accepted. Rather, main effect models were used to test for significant differences (at alpha=.01) among instructional methodologies, age, and gender cohorts. Contrasts comparing success/failure within cohorts were also constructed and tested for statistical significance.

Frequency tables were generated to determine what combination of factor levels could be studied. Once this was done, the response was modeled using, SAS CATMOD a procedure used for categorical data modeling. Specifically, a loglinear response model applying the maximum likelihood method for estimating model parameters was used. After parameters were estimated, hypothesis tests and contrasts were performed.

FINDINGS
(Main Effect Models)

The following illustrate those statistically significant variations in performance found as a result interactions between the independent variables and instructional modalities.

Note the following:

* = significant at the .01 level of probability
** = significant at the .001 level of probability
*** = significant at the .0001 level of probability.

Only those interactions with statistical significance will be listed.

Effect of Instructional Modality (Student Category) on Graduate Performance

TABLE #8
Population Profile: Student Category

STUDENT CATEGORY		SAMPLE SIZE	MEAN QPA
0	On-Campus Degree	3,759	3.30
1	On-Campus Non-Degree	113	2.12
2	Off-Campus, Non-Interactive, Degree	915	3.44
3	Off-Campus, Non-Interactive, Non-Degree	1,084	2.96
4	Off-Campus, Interactive, Degree	1,124	3.25
5	Off-Campus, Interactive, Non-Degree	1,436	2.95

QUESTION #1: Does student category have a significant effect on success/failure in graduate engineering performance?

TABLE #9
Analysis of Variance Table

Source	DF	CHI-SQUARE	PROBABILITY
Intercept	1	984.29	0.0001
Student Category	5	261.27	0.0001 ***

Yes Significant to the 0.0001 level

QUESTION #2: Are significant variations in success/failure in graduate engineering performance found between student categories?

TABLE #10
Analysis of Contrasts

Contrasts	DF	CHI-SQUARE	PROBABILITY
0,2,4 vs. 1,3,5 (3.31 vs. 2.92)	1	176.35	0.0001 ***
1 vs. 3,5 (2.12 vs. 2.95)	1	11.23	0.0008 **
0 vs. 2 (3.30 vs. 3.44	1	15.12	0.0001 ***
2 vs. 4 (3.44 vs. 3.25)	1	16.04	0.0001 ***
1 vs. 3 (2.12 vs. 2.96)	1	13.41	0.0002 **
1 vs. 5 (2.12 vs. 2.95)	1	8.18	0.0042 *

Effects of Student Gender on Graduate Performance (In the Aggregate and Between Student Categories)

TABLE #11
Population Profile: Student Gender by Category

	Male		Female	
Student Category	n=	Mean QPA	n=	Mean QPA
On-Campus Degree (0)	1,319	3.12	262	3.20
On-Campus, Non-Degree (1)	89	2.06	2	2.37
Off-Campus, Non-Interactive, Degree (2)	193	3.27	24	3.54
Off-Campus, Non-Interactive, Non-Degree(3)	218	2.98	28	3.19
Off-Campus, Interactive, Degree (4)	958	3.23	158	3.33
Off-Campus, Interactive, Non-Degree (5)	1,226	2.78	210	2.96

QUESTION #1: Does gender have a significant effect on success/ failure in graduate engineering performance?

TABLE #12
Analysis of Variance Table

Source	DF	CHI-SQUARE	PROBABILITY
Intercept	1	328.88	0.0001
Gender	1	3.77	0.0523
Student Category	5	106.83	0.0001

No

QUESTION #2: Are significant variations in success/failure among male engineering graduate students found between instructional categories?

TABLE #13
Analysis of Contrasts: MALE

Contrasts	DF	CHI-SQUARE	PROBABILITY
0,2,4 vs. 1,3,5 (3.41 vs. 2.77)	1	52.82	0.0001 ***
0 vs. 2,4 (3.12 vs. 3.24)	1	6.65	0.0099 *
1 vs. 3,5 (2.06 vs. 2.80	1	13.80	0.0002 **
1 vs. 3 (2.06 vs. 2.98)	1	14.94	0.0001 ***
1 vs. 5 (2.06 vs. 2.78)	1	9.23	0.0024 *

QUESTION #3: Are significant variations in success/failure among female engineering graduate students found between instructional categories?

No

Effects of Chronological Age on Graduate Performance
(In the Aggregate and Within Student Categories)

TABLE #14
Population Profile: Student Age by Category

n=
Mean QPA

STUDENT CATEGORY	22-25	26-30	31-35	35-40	40+
On-Campus	2,330	901	282	90	76
Degree (0)	3.33	3.26	3.21	3.57	3.14
On-Campus,	41	47	13	3	7
Non-Degree (1)	2.12	2.21	1.77	0	3.29
Off-Campus/Non-Int	210	364	191	103	45
Degree (2)	3.38	3.43	3.64	3.33	3.28
Off-Campus/Non-Int	342	323	214	86	113
Non-Degree (3)	3.09	2.98	2.91	2.84	2.83
Off-Campus/Int	383	447	184	70	38
Degree (4)	3.33	3.09	3.27	3.47	3.67
Off-Campus/Int	522	463	179	90	92
Non-Degree (5)	2.88	2.68	2.83	2.85	2.64

QUESTION #1: Does student age have a significant effect on success/failure in graduate engineering performance?

TABLE #15
Analysis of Variance Table

Source	DF	CHI-SQUARE	PROBABILITY
Intercept	1	655.25	0.0001
Student Category	5	243.08	0.0001
Chronological Age	4	21.51	0.0003

Yes Significant at .001 level

QUESTION #2: Are significant variations in success/failure in graduate engineering performance found between student categories among 22-25 year olds?

TABLE #16

Analysis of Contrasts: 22-25 YEAR OLDS

Contrasts	DF	CHI-SQUARE	PROBABILITY
0,2,4 vs. 1,3,5 (3.33 vs. 2.92)	1	49.81	0.0001 ***
1 vs. 3,5 (2.12 vs. 2.96)	1	9.15	0.0025 *
1 vs. 3 (2.12 vs. 3.09)	1	10.57	0.0011 *
1 vs. 5 (2.12 vs. 2.88)	1	6.75	0.0094 *

QUESTION #3: Are significant variations in success/failure in graduate engineering performance found between student categories among 26-30 year olds?

TABLE #17

Analysis of Contrasts: 26-30 YEAR OLDS

Contrasts	DF	CHI-SQUARE	PROBABILITY
0,2,4 vs. 1,3,5 (3.25 vs. 2.77)	1	48.25	0.0001 ***
0 vs. 2 (3.26 vs. 3.43)	1	7.26	0.0071 *
2 vs. 4 (3.43 vs. 3.09	1	16.02	0.0001 ***
3 vs. 5 (2.98 vs. 2.68)	1	7.69	0.0056 *

QUESTION #4: Are significant variations in success/failure in graduate engineering performance found between student categories among 31-35 year olds?

TABLE #18

Analysis of Contrasts: 31-35 YEAR OLDS

Contrasts	DF	CHI-SQUARE	PROBABILITY
0,2,4 vs. 1,3,5 (3.35 vs. 2.84	1	42.05	0.0001 ***
0 vs. 2,4 (3.21 vs. 3.46)	1	15.79	0.0001 ***
0 vs. 2 (3.21 vs. 3.64)	1	19.81	0.0001 ***
2 vs. 4 (3.64 vs. 3.27)	1	15.29	0.0001 ***

QUESTION #5: Are significant variations in success/failure in graduate engineering performance found between student categories among 36-40 year olds?

No

QUESTION #6: Are significant variations in success/failure in graduate engineering performance found between student categories among enrollees over 40?

No

CONCLUSIONS

The data and their analyses support the contention that off-campus graduate engineering students do not suffer from the inability to "talk back" to faculty in real time. Indeed the current research speaks to the contention that distance students perform better where they control not only where but when learning occurs.

This seems especially true for men in the 26 to 30 and 31 to 35 year old cohorts who, during this stage of their personal lives and professional careers, are hard pressed to balance the myriad demands placed on their time. For this group, videotape's inherent flexibilitas seem not only desireable but significant in terms of success. It may even provide the "value added" benefits that candid-classroom's critics have long said are not provided in this instructional modality.

None of this is to suggest that faculty and students do not need to interact. However, data indicate that as long as levels of student/faculty interaction are at a tier both necessary and sufficient to support quality instruction, even though not carried out in real-time, non-interactive delivery formats are both useful and effective in balancing competing work and school demands.

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Dr. Harvey Stone currently serves as Special Assistant to the President and Assistant Professor of Education at the University of Delaware. His primary administrative responsibilities include supporting that institution's efforts as they relate to economic development.

He has also be responsible for planning, coordinating, and funding the University of Delaware's major initiative in media-assisted off-campus distance education.

For the past five years, he has maintained an active research and publication program with emphasis on the support of university/industry interaction through distance education. His primary areas of concern include the effectiveness of video-based distance education and that technology's adoption and utilization by faculty in a research university environment.